化學藥劑預措對玫瑰切花低溫乾藏後老化生理之影響

林瑞松 郭玫秀
國立中興大學園藝系教授與前研究生

摘 要

本試驗利用黛安娜'Noblesse'玫瑰切花商業栽培品種作爲試驗材料，調查低溫乾藏後關鍵老化機制之探討，並針對冷藏後生理的劣變研發利用適合之藥劑加以改善。玫瑰切花經由 100 ppm Agral-LN 預措對於貯藏切花鮮重之維持僅於瓶插初期有效用，10 mM proline 及 10 mM $CaCl_2$ 處理皆可以提升切花貯藏後之吸水能力並促進花朵的開放。切花經低溫貯藏後常會造成膜體性質的改變、乙烯的生成及離子滲漏率的增加，使用 $CaCl_2$ 預措則可顯著的抑制 ACO 的活性，進而降低乙烯的生成，並且有降低膜體微黏稠度的效果，尤其可延緩 8℃貯藏之切花細胞微黏稠度的提升，而接近 4℃貯藏者之變化趨勢，並藉由穩定膜體完整性，達到改善貯藏後切花品質之目的。

關鍵字：玫瑰切花、老化生理、細胞膜微黏稠度、乙烯

前 言

低溫貯藏是園產品採後處理過程中常利用之方法，主要作用在於減緩切花代謝生理與老化的進行(Halevy and Mayak, 1979; Goszczynska et al., 1988)。然切花經低溫貯藏後，極易造成切花提早萎凋(Faragher et al., 1986)、花朵不易綻放、垂頸、花瓣藍化(Faragher et al., 1984)等劣變問題；在切花生理方面，隨著冷藏溫度的增加或冷藏時間的增加，花瓣離子滲漏率及膜體微黏性會大幅上升(Faragher et al., 1987)，導致貯藏後壽命的縮短(Faragher and Mayak, 1984)。因此本試驗利用黛安娜'Noblesse'玫瑰切花商業栽培品種作爲試驗材料，針對冷藏後生理的劣變研發使用適合之藥劑加以改善。

材料與方法

一、植物材料

商業栽培品種黛安娜'Noblesse'玫瑰切花(*Rosa hybrida* L.)選取自南投埔里花卉生產合作社，於商業採收成熟度時採收，切花品質屬於 A 級品(花型完整，花色鮮明帶光澤，成熟度佳，葉色鮮綠明亮均勻對稱，花莖堅實長直具韌性)。切花自產地當日採收以濕式運輸方式於 3 小時內運抵實驗室，以供試驗之用。

二、試驗方法

選取最適合之藥劑濃度 10 mM 脯胺酸(proline)、10 mM 氯化鈣($CaCl_2$)、100 ppm 界面活性劑(Agral-LN)，於 15℃下預措 16 小時。分別以未貯藏及置於 4℃、8 ℃下乾藏 2 週處理。瓶插期間每日測量切花鮮重、吸水性、花朵開放度、呼吸率及乙烯生成量，並於鬆蕾期(S2)、盛開期(S3)、萎凋期(S5)測定花瓣基部 ACC 含量與 ACO 活性、電解質滲漏率與花瓣膜體物理結構之變化。

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stage 1－緊蕾(tight bud)商業採收成熟度，花瓣緊密包埋
stage 2－鬆蕾(loosed bud)第一輪外圍花瓣展開或反捲
stage 3－盛開(fully open)花朵達最大開放直徑
stage 4－初萎(outer petals reflexed)第一輪外圍花瓣反捲
stage 5－萎凋(senescence, adding, blacking)花瓣明顯萎凋褪色

stage1 stage2 stage3 stage4 stage5

結果與討論

一、藥劑預措對切花品質之影響

'Noblesse'玫瑰切花利用不同藥劑 10 mM proline、10 mM $CaCl_2$、100 ppm Agral-LN 預措 16 小時，分別以未貯藏及 4℃、8℃下乾藏 2 週處理。結果顯示 Agral-LN 對於未貯藏切花鮮重之維持最佳，然對於貯藏切花之效用則僅限於瓶插初期(圖 2)。Van Doorn 等(2002)指出 Agral-LN 可促使切花於乾藏後回復膨潤狀態。可能的作用機制爲促進水分再次流入乾燥的維管束管壁，並改善導管與氣穴間的交互作用(Van Doorn et al., 1993a)。然而施用不當容易造成毒害使葉片脫落(Van Doorn et al., 1993b)。

圖 1. 化學藥劑預措對`Noblesse'玫瑰切花貯藏 2 週後瓶插第 4 天外觀品質之影響。
Fig1. Effect of pulsed with chemicals followed by 2 weeks storage at 4℃ on flower quality of 'Noblesse' cut rose flowers placed on distilled water for 4 days. (A) In side view. (B)Pulsed with distilled water. (C) Pulsed with $CaCl_2$.

Borochov 等(1999)利用 $CaCl_2$ 處理玫瑰切花可以延緩老化的進行並促使花朵開放，其作用機制可能是作爲膜的穩定劑而延緩滲漏的發生。試驗中 $CaCl_2$ 預措對於切花貯藏後鮮重及吸水能力(圖 3)的維持效果最佳。切花貯藏後常會造成花朵無法開放，經由藥劑處理皆可改善，其中以 $CaCl_2$ 預措效果最顯著(圖 1)。

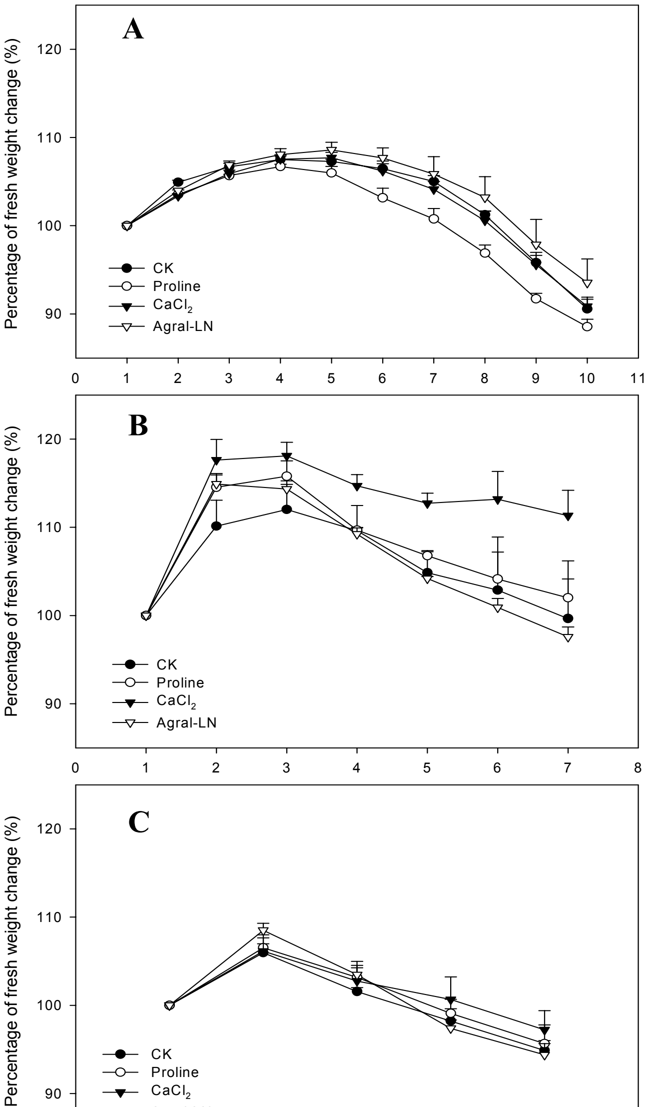

圖 2. 化學藥劑預措對 ‘Noblesse’玫瑰切花鮮重變化之影響。

Fig. 2. Effect of pulsed with chemicals on fresh weight change of ‘Noblesse’ cut rose flowers . Each value represents the mean of 3 replications ± SE. Each replication was 3 flowers.

Note: (A):no storage, (B): 2 weeks storage at 4℃, (C): 2 weeks storage at 8℃. CK: distilled water pulsed 16hrs at 15℃.

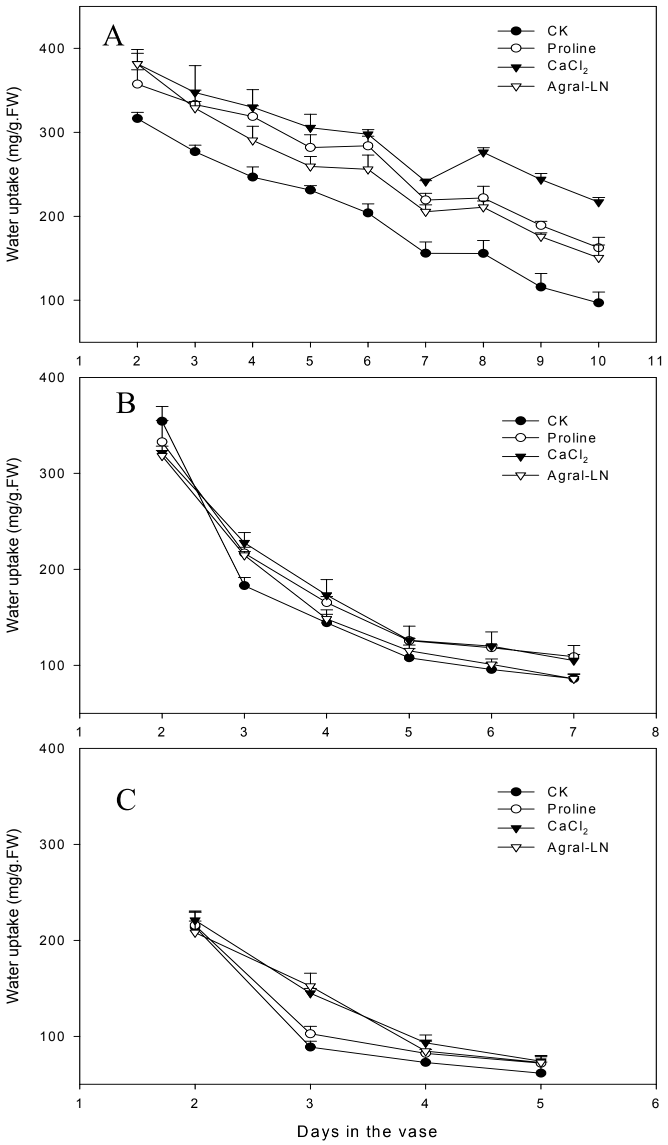

圖 3. 化學藥劑預措對 'Noblesse'玫瑰切花吸水量變化之影響。

Fig. 3. Effect of pulsed with chemicals on water uptake change of 'Noblesse' cut rose flowers . Each value represents the mean of 3 replications ± SE. Each replication was 3 flowers.

Note: (A):no storage, (B): 2 weeks storage at 4℃, (C): 2 weeks storage at 8℃. CK: distilled water pulsed 16hrs at 15℃.

二、藥劑預措對切花乙烯生合成之影響

切花貯藏後會促使乙烯大量生成，大體上以對照組(蒸餾水預措)乙烯生成量最高，然於瓶插後期會迅速降低。藥劑處理無論是否經過貯藏皆以 $CaCl_2$ 抑制效果最佳，且與對照組呈現顯著差異(圖 4)。Cheverry 等(1988)利用 $CaCl_2$ 處理蘋果組織也可抑制乙烯生成。另外 Song 等(1992)指出，由於乙烯生成途徑中由 ACC 轉變爲乙烯的階段必須要有自由基的參與，因此鈣可能經由降低自由基的生成，而抑制 ACC 轉化爲乙烯的能力。

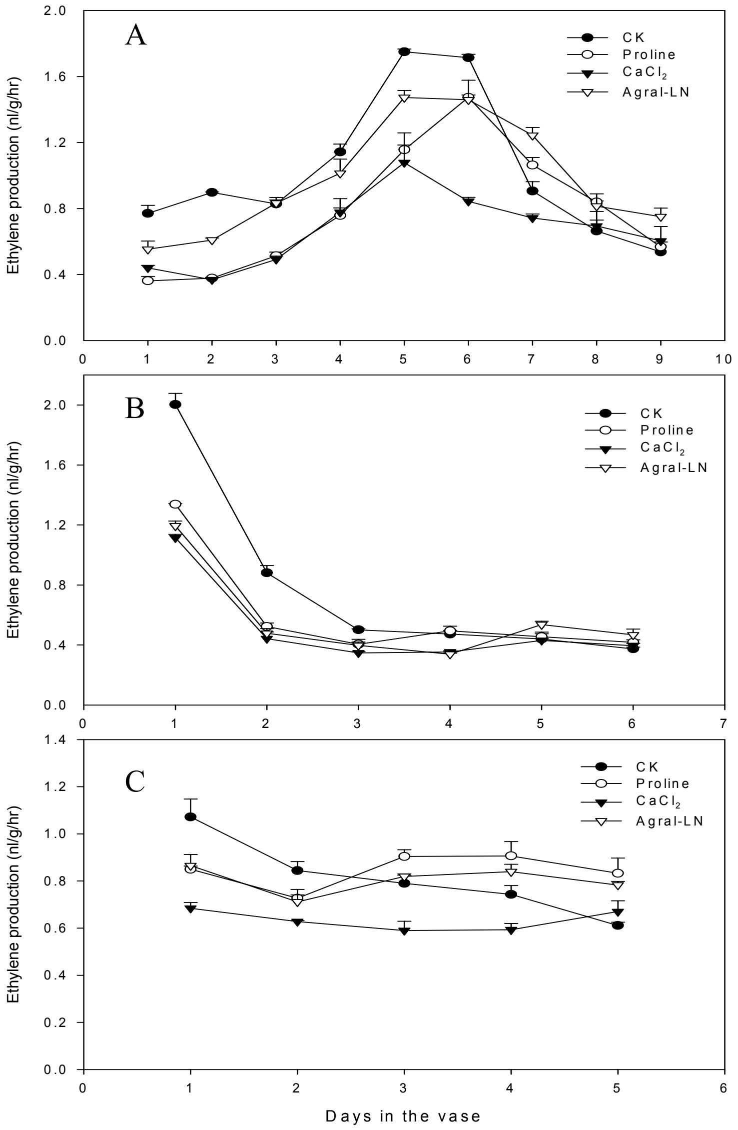

圖 4. 化學藥劑預措對 'Noblesse'玫瑰切花乙烯生成量變化之影響。

Fig. 4. Effect of pulsed with chemicals on ethylene production change of 'Noblesse' cut rose flowers . Each value represents the mean of 3 replications ± SE. Each replication was 3 flowers.

Note: (A):no storage, (B): 2 weeks storage at 4℃, (C): 2 weeks storage at 8℃. CK: distilled water pulsed 16hrs at 15 ℃.

切花貯藏後會大量累積 ACC，尤其以 8℃貯藏者至萎凋期高達 2.8-3.09 nmol/g。不論何種處理在花朵萎凋期 ACC 的累積量均會達到高峰，這是由於萎凋期 ACO 活性下降之故，藥劑處理對於 ACC 的生成並無影響(表 1)。Cheverry 等(1988)指出經由 $CaCl_2$ 處理後，不論是在添加或是缺乏 ACC 的情況下，皆可抑制乙烯的生成，因此推測鈣對於乙烯的抑制作用應該是在 ACC 形成乙烯的階段。試驗結果也顯示，經由 $CaCl_2$ 預措可以顯著抑制 ACO 的活性，尤其在鬆蕾期皆呈現顯著差異(表 2)。

表 1. 化學藥劑預措對 'Noblesse'玫瑰切花 ACC 含量之影響。
S2,S3,S5 各代表鬆蕾期，盛開期，萎凋期。
Table 1. Effect of pulsed with chemicals on 1-aminocyclopropane-1-carboxylic acid (ACC) content of 'Noblesse' cut rose flowers.

Chemicals pulse	ACC (n mol/g)								
	No storage			Cold storage in 4℃			Cold storage in 8℃		
	S2	S3	S5	S2	S3	S5	S2	S3	S5
CK[z]	0.48 a[y]	0.31 a	0.81 a	0.75 a	0.80 a	1.34 a	2.18 a	2.98 a	3.09 a
10 mM Proline	0.30 b	0.39 a	0.69 a	0.69 a	0.71 a	1.05 a	1.78 b	2.70 a	2.80 a
10 mM $CaCl_2$	0.32 b	0.42 a	0.83 a	0.67 a	0.69 a	1.06 a	2.10 a	2.74 a	3.26 a
100 ppm Agral-LN	0.28 b	0.37 a	0.69 a	0.71 a	0.78 a	1.13 a	1.96 b	2.70 a	3.01 a

z: distilled water pulsed 16hrs at 15℃.
y: Mean separation within column by Duncan' s multiple range test, 5% level. Each value represented the mean of 3 replication. Each replications 2 flowers.

表 2. 化學藥劑預措對 'Noblesse'玫瑰切花 ACO 活性變化之影響。
S2,S3,S5 各代表鬆蕾期，盛開期，萎凋期。
Table 2. Effect of pulsed with chemicals on ACC oxdiase (ACO) activity change of 'Noblesse' cut rose flowers.

Chemicals pulse	ACO (nl /g FW .hr)								
	No storage			Cold storage in 4℃			Cold storage in 8℃		
	S2	S3	S5	S2	S3	S5	S2	S3	S5
CK[z]	18.86a[y]	14.28 a	15.27a	13.85a	9.49 c	9.45 b	12.07 a	9.87ab	.01ab
10 mM Proline	17.58 b	14.36 a	15.62a	14.25 a	12.33a	11.31 a	11.88 a	10.32 a	9.18 a
10 mM $CaCl_2$	13.50 c	11.86 c	11.84 c	11.37 b	11.41ab	9.47 b	9.73 b	8.30 c	7.80 b
100 ppm Agral-LN	19.80 a	13.02 b	12.86b	14.14 a	10.94b	9.25 b	11.65 a	9.06bc	8.57ab

z: distilled water pulsed 16hrs at 15℃.
y: Mean separation within column by Duncan' s multiple range test, 5% level. Each value represents the mean of 3 replications ± SE. Each replication was 1 flower.

三、藥劑預措對花瓣膜體性質之影響

'Noblesse'玫瑰切花微粒體膜(microsomal membrane)之微黏稠度(microviscosity)，隨著發育階段而呈現升高的趨勢，且在鬆蕾期至盛開期此發育階段大幅上升（圖 5）。Thompson 等(1982)利用電子旋轉共振(electron spin resonance, ESR)測定膜之流動性也有相同情形，此數值在老化初期緩慢降低，並於老化症狀出現之前大幅下降。

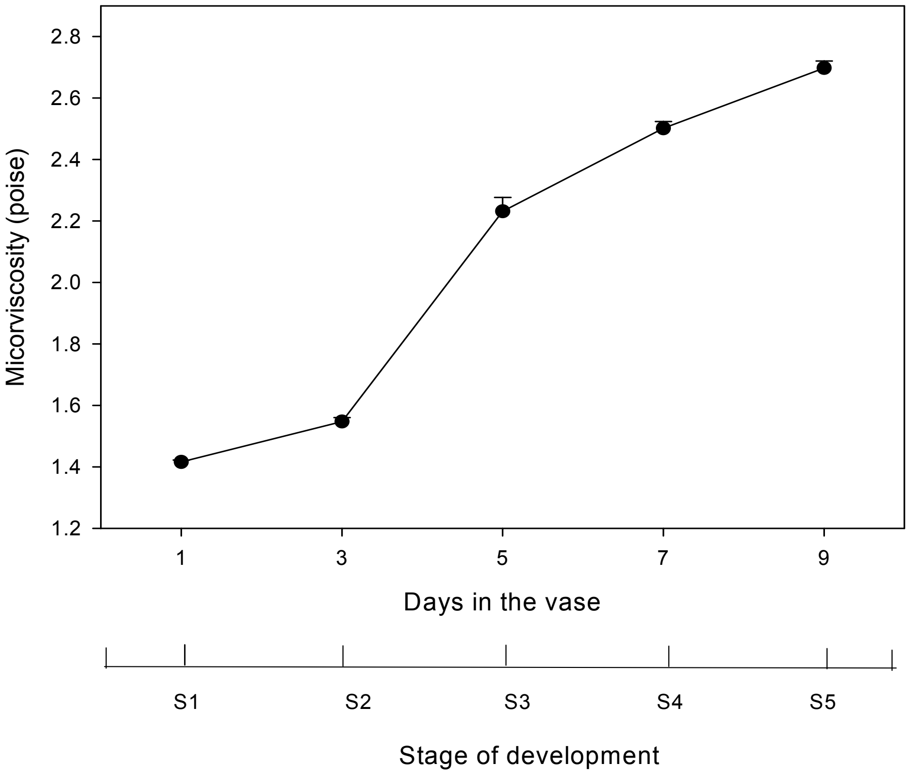

圖 5. 'Noblesse'玫瑰切花於不同發育階段花瓣微粒體膜中微黏稠度數值之變化。
S1,S2,S3,S4 和 S5 各代表緊蕾期、鬆蕾期、盛開期、初萎期和萎凋期

Fig.5. Microviscosity of microsomal membrane obtained from 'Noblesse' rose petal at different stages of development. Each value represents the mean of 2 replications ± SE. Each replication was 3 flowers.

Cheour 等(1992)指出甘藍葉圓片經由 $CaCl_2$ 處理，可以降低磷脂質降解產物如二脂醯甘油(DAG)及游離脂肪酸的生成，而延緩磷脂質的衰退，此作用可能是經由抑制磷脂質酵素的活性而達成。試驗中未貯藏之切花於瓶插第 3 天(鬆蕾期)至瓶插第 5 天(盛開期)急速上升，經由 $CaCl_2$ 處理可以降低微黏稠度數值 0.25 poise；8℃貯藏之切花於瓶插第 1 天即迅速提升，利用 $CaCl_2$ 處理可以延緩微黏稠度至瓶插第 2 天提升，並可降低近 0.89 poise，而接近 4℃貯藏者之變化趨勢，顯示，$CaCl_2$ 處理可以有效的延緩並降低貯藏後花瓣膜體物理性質之變化，尤其以 8℃貯藏之切花，$CaCl_2$ 處理可以延緩微黏稠度的提升，並且達到與 4℃貯藏相似的趨勢(圖 6)。另有學者指出玫瑰切花以 $CaCl_2$ 噴施，可提高 Superoxide simutase(SOD)之活性，藉由清除自由基的功能，維持膜結構之穩定性(洪和超，1999)。

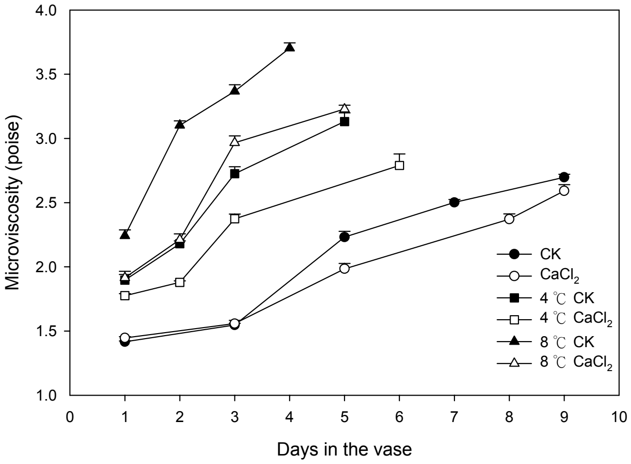

圖 6. 化學藥劑預措對 ‘Noblesse’玫瑰切花花瓣微粒體膜中微黏稠度數值變化之影響。

Fig. 6. Effect of pulsed with chemicals on Microviscosity change of petal microsomal membrane of ‘Noblesse’ cut rose flowers . Each value represents the mean of 3 replications ± SE. Each replication was 3 flowers.

Note: (○):no storage, (□): 2 weeks storage at 4℃, (△): 2 weeks storage at 8℃. CK: distilled water pulsed 16hrs at 15℃.

Borochov 等(1999)利用 $CaCl_2$ 處理玫瑰切花，可以顯著的降低離子滲漏率及延緩隔室作用的瓦解。試驗中經貯藏切花之滲漏率均明顯的高於對照組，顯示切花貯藏後膜體已遭受破壞，而 $CaCl_2$ 處理對於維持膜體的完整性相當具有成效(圖 7、8)。

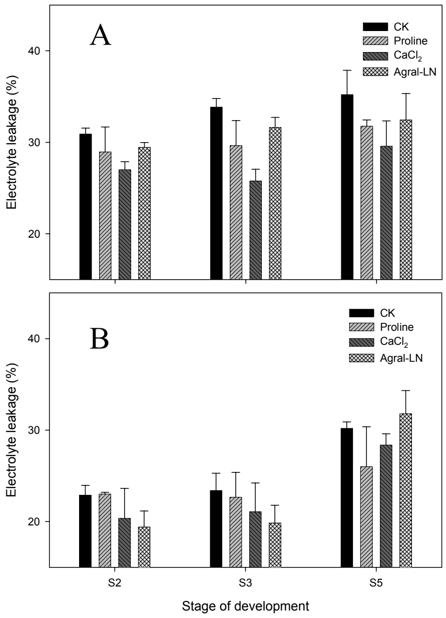

圖 7. 化學藥劑預措對 ‘Noblesse’玫瑰切花離子滲漏率之影響。
S1,S2,S3,S4 和 S5 各代表緊蕾期、鬆蕾期、盛開期、初萎期和萎凋期

Fig.7. Effect of pulsed with chemicals on electrolyte leakage of ‘Noblesse’ cut rose flowers . Each value represents the mean of 3 replications ± SE. Each replication was 2 flowers.

Note: no storage, (A):outer petal top, (B): outer petal base, CK: distilled water pulsed 16hrs at 15℃.

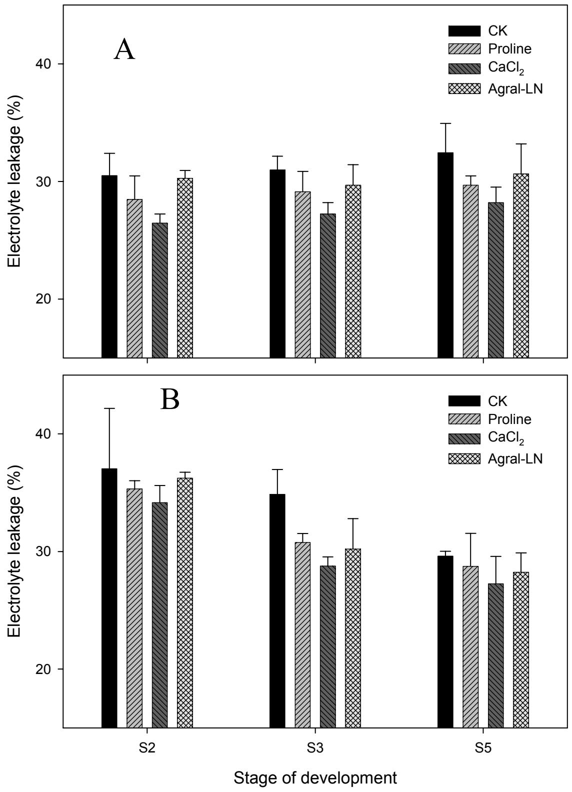

圖 8. 化學藥劑預措對 ‘Noblesse’玫瑰切花花瓣邊緣離子滲漏率之影響。

Fig. 8. Effect of pulsed with chemicals on electrolyte leakage for outer petal top of‘Noblesse’ cut rose flowers . Each value represents the mean of 3 replications ± SE. Each replication was 2 flowers.

Note: (A): 2 weeks storage at 4℃, (B): 2 weeks storage at 8℃, CK: distilled water pulsed 16hrs at 15℃

另外利用 proline 預措處理對於貯藏後切花之離子滲漏率也有延緩的效果(圖 8)。Rudolph 等(1986)指出 proline 在低溫貯藏過程中具有穩定膜磷脂質的作用。並可改善玫瑰切花貯藏後膜完整性的喪失(Tonecki et al., 1989)。而 Agral-LN 對於貯藏後膜體完整的維持效果不顯著(圖 8)。

這些試驗結果顯示，‘Noblesse’玫瑰切花利用 10 mM $CaCl_2$ 預措，可藉由延緩並降低花瓣膜微黏稠度的變化(圖 6)、乙烯的生成(圖 4)及穩定膜體的完整性(圖 7、8)，來達到改善低溫貯藏後玫瑰切花品質的目的。

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Effects of Chemical Pretreatment on the Senescence Physiology of Cut Rose after Dry Cold Storage

Ruey-Song Lin, Mei-Hsiu Kuo
Professor and Graduate Student,
Department of Horticulture, National Chung-Hsing University.

Summary

Cut flower of *Rosa Hybrida* L. cv. 'Nobless' was studied to investigate the crucial aging mechanism after dry cold storage to improve the deteriorated damage cold storage flowers resulted from disorder physiological changes of cut roses. The cut flowers pulsed with 100 ppm Agral-LN, could only maintain its fresh weight at the early stage in vase. Cut rose pulsed with 10 mM proline and 10 mM $CaCl_2$ could enhance the water uptake capability and promote the flower opening after cold storage. The cold storage cut roses existed membrane characteristic changes, increase of ethylene production and electrolyte leakage. Consequently, flowers pulsed with $CaCl_2$, the ACO activity could be inhibited significantly, the ethylene production could be reduced, and the membrane microviscosity was less than no treatment had. As a result the cut flowers handled with 8°C storage could delay the increase trend of microviscosity and its pattern was similar to that cut roses handled with 4°C storage. In terms of stability of membrane integrity through delayed membrane microviscosity on rising trend, the accomplishment of quality improvement of flowers which suffered cold stored came true.

Key words：cut rose, senescence physiology, membrane microviscosity, ethylene